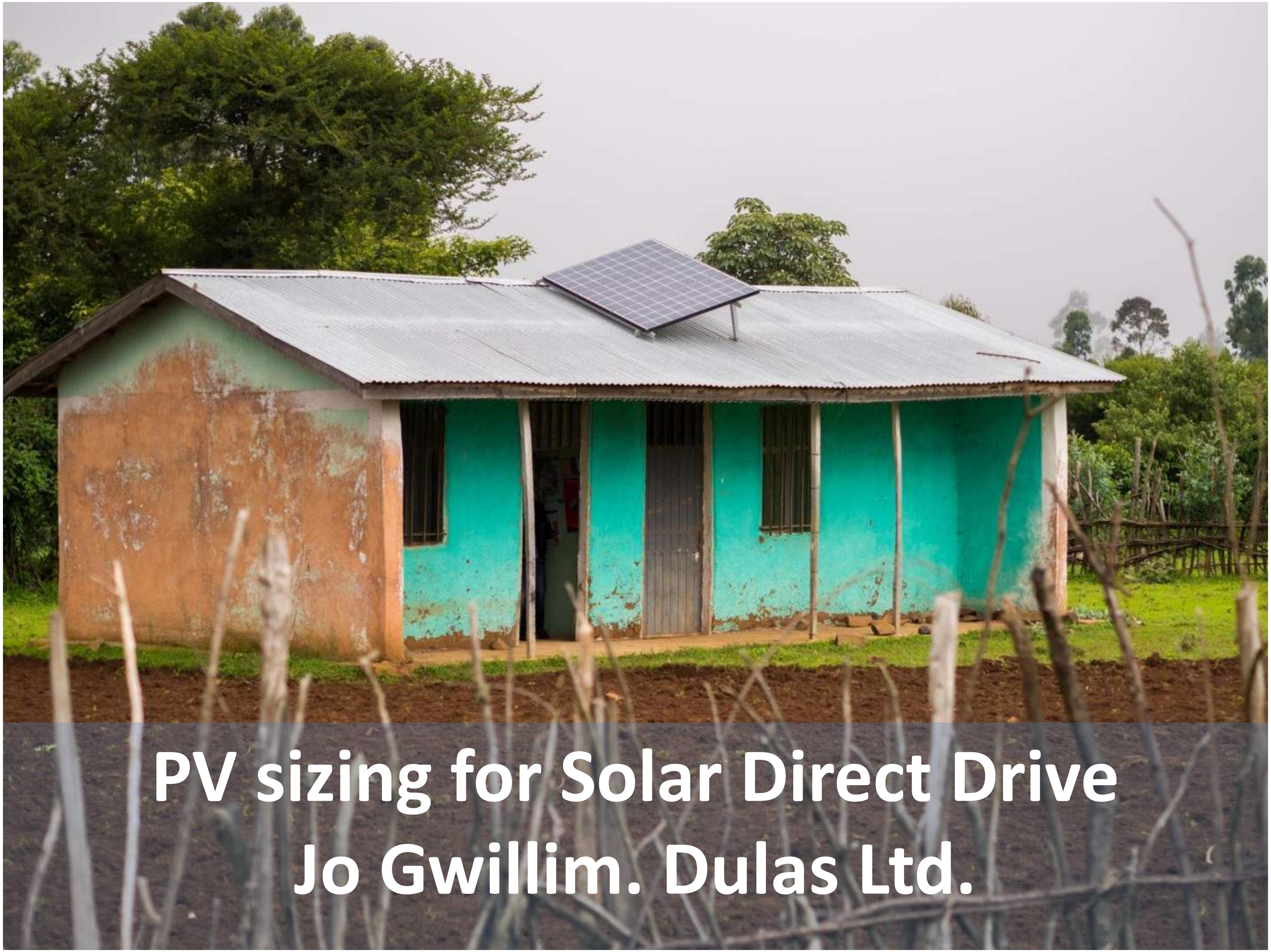

# PV sizing for Solar Direct Drive

Jo Gwillim. Dulas Ltd.

## The design goal:

Keep vaccines at the right temperature.
24 hours per day.
365 days per year.
Using solar power without battery storage.

## The challenges:

No sun at night.
Cloudy weather.
High air temperatures.
PV shading.
Dirt on PVs.
Remote locations – we have to get it right

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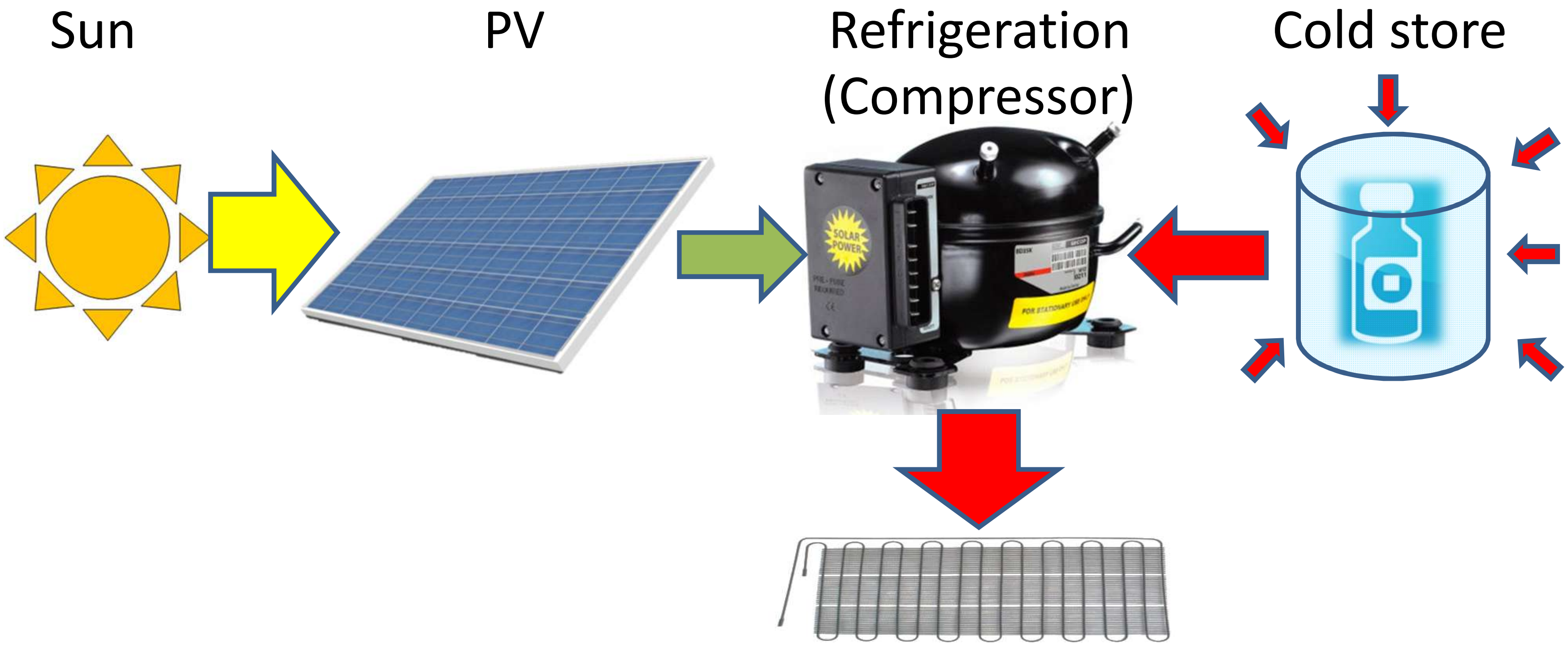
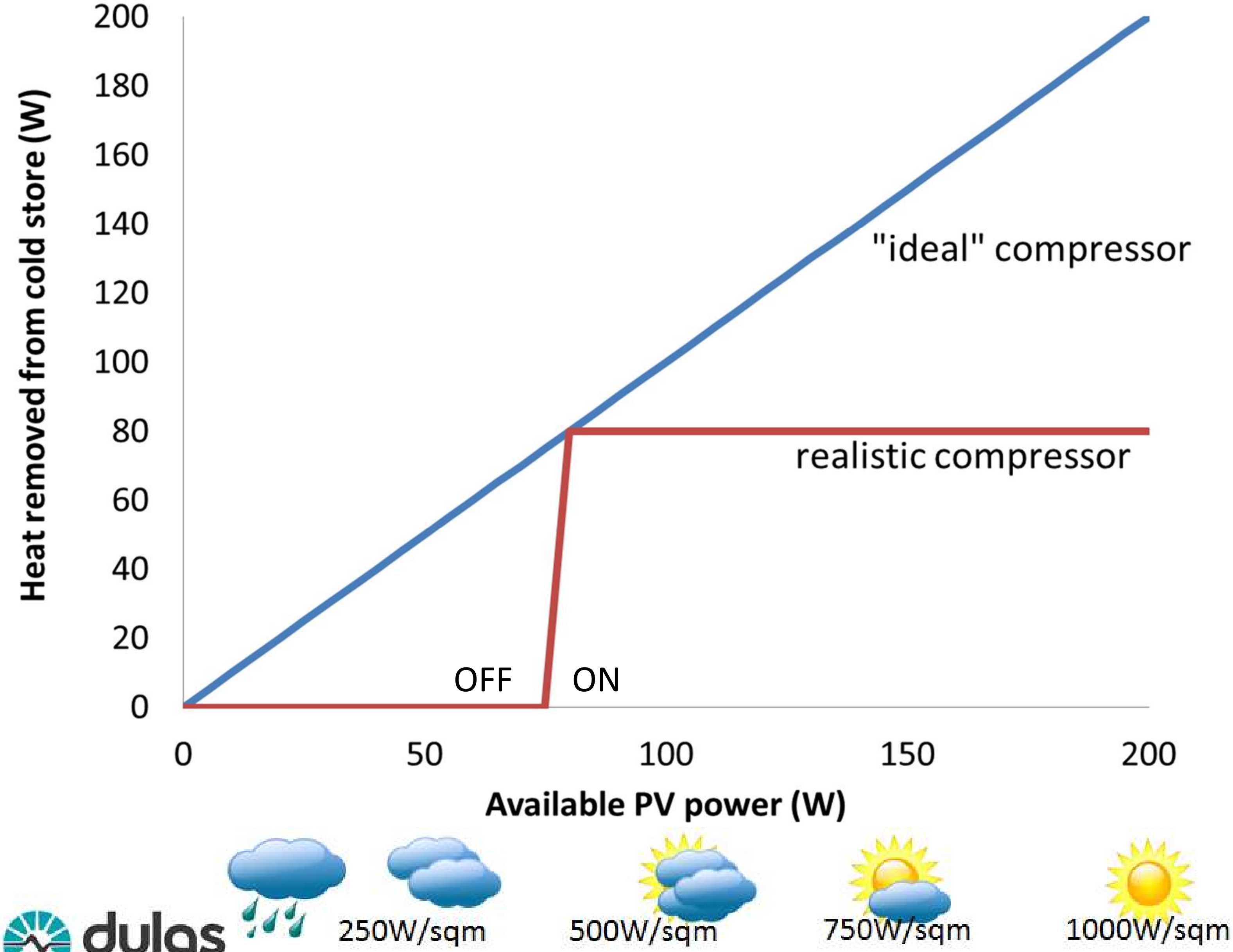
# The design




How much PV do we need?
How good does the insulation need to be?
How big does the cold store need to be?
How well can the compressor do its job?
**These are all interconnected.**

# The match between PV and compressor is far from ideal

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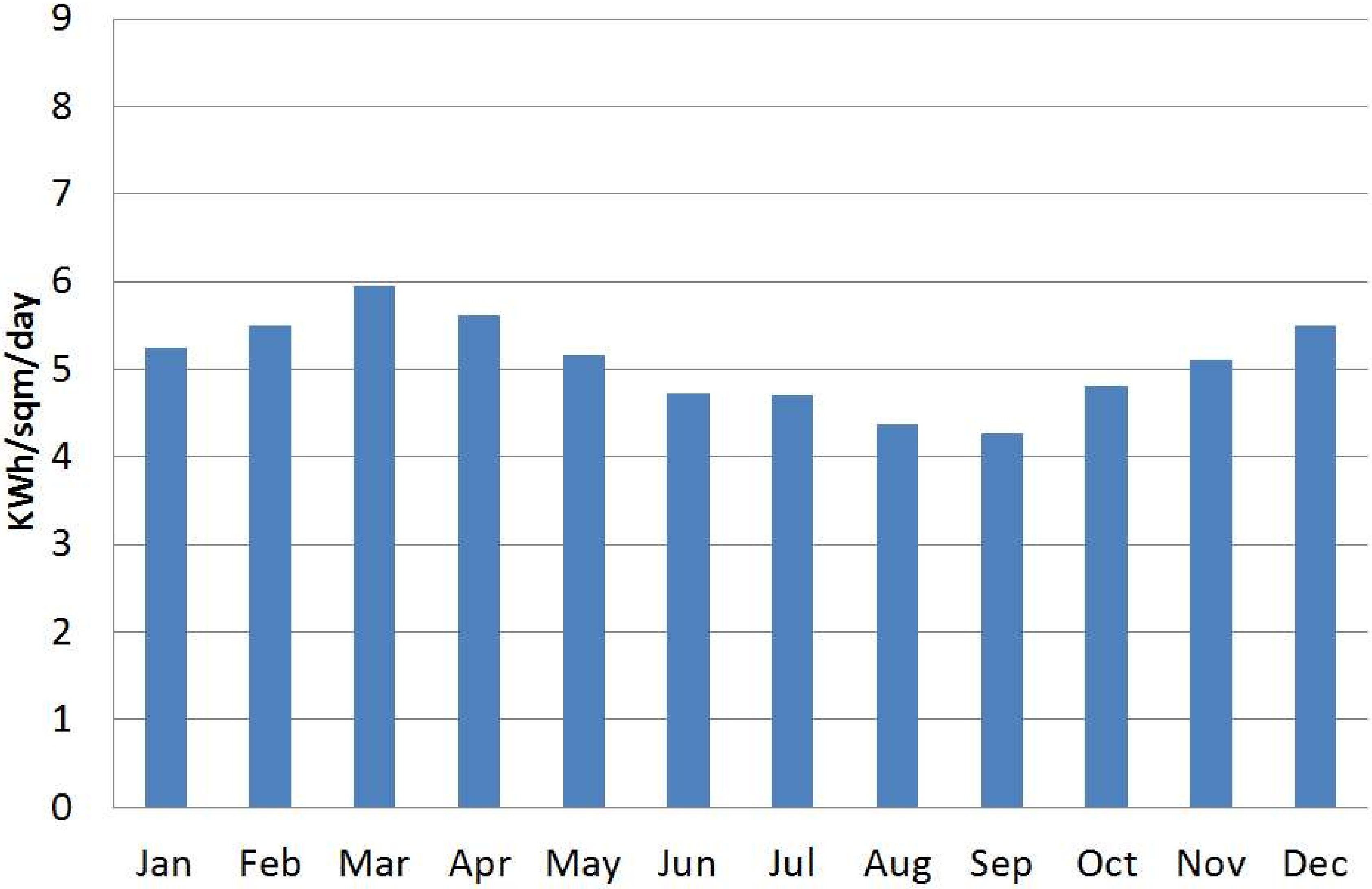
# Sizing the energy supply (PV)

# Sizing of battery based systems often used monthly averages for solar data

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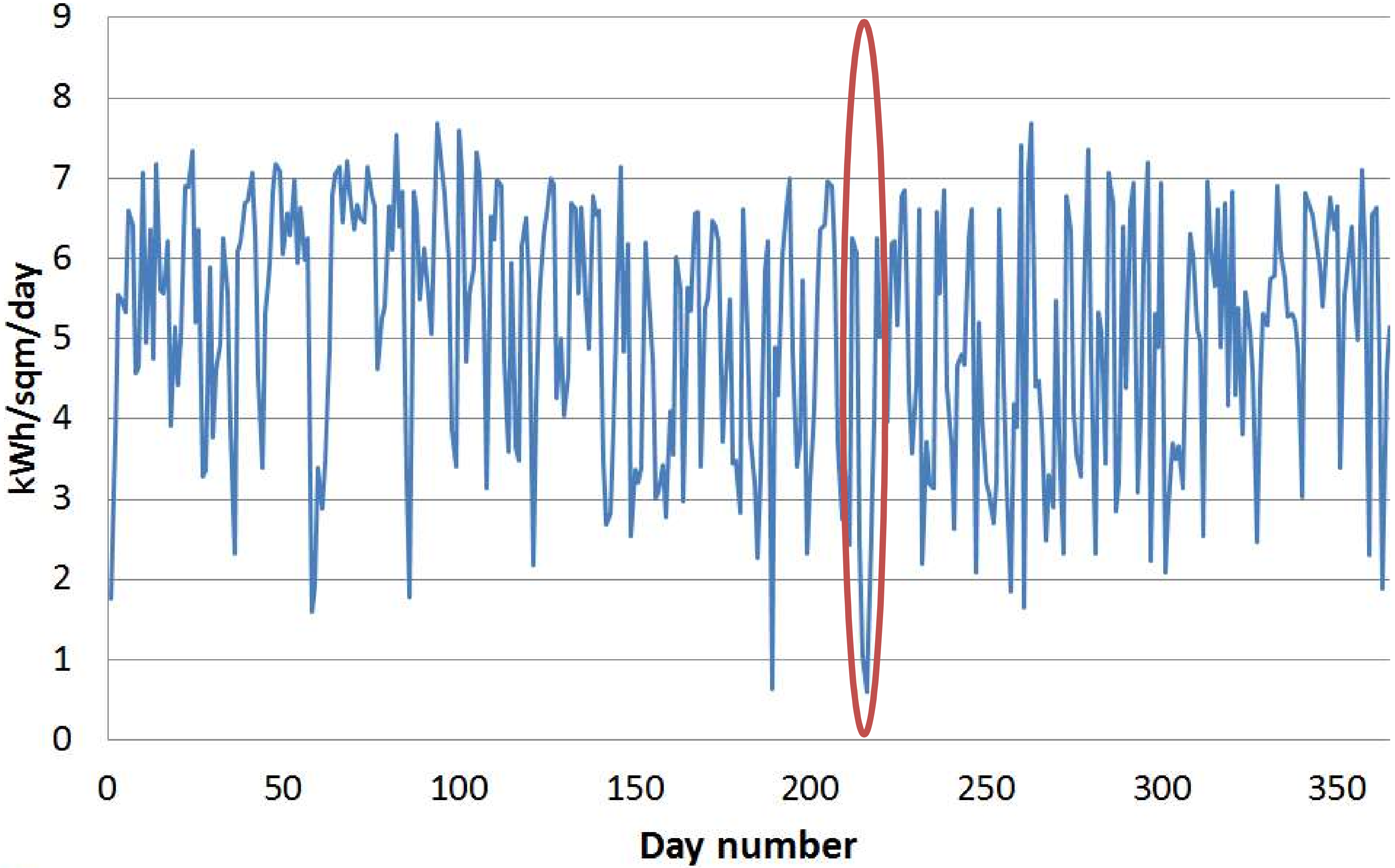
# Daily averages for data indicate that even in a good month there can be very dull days

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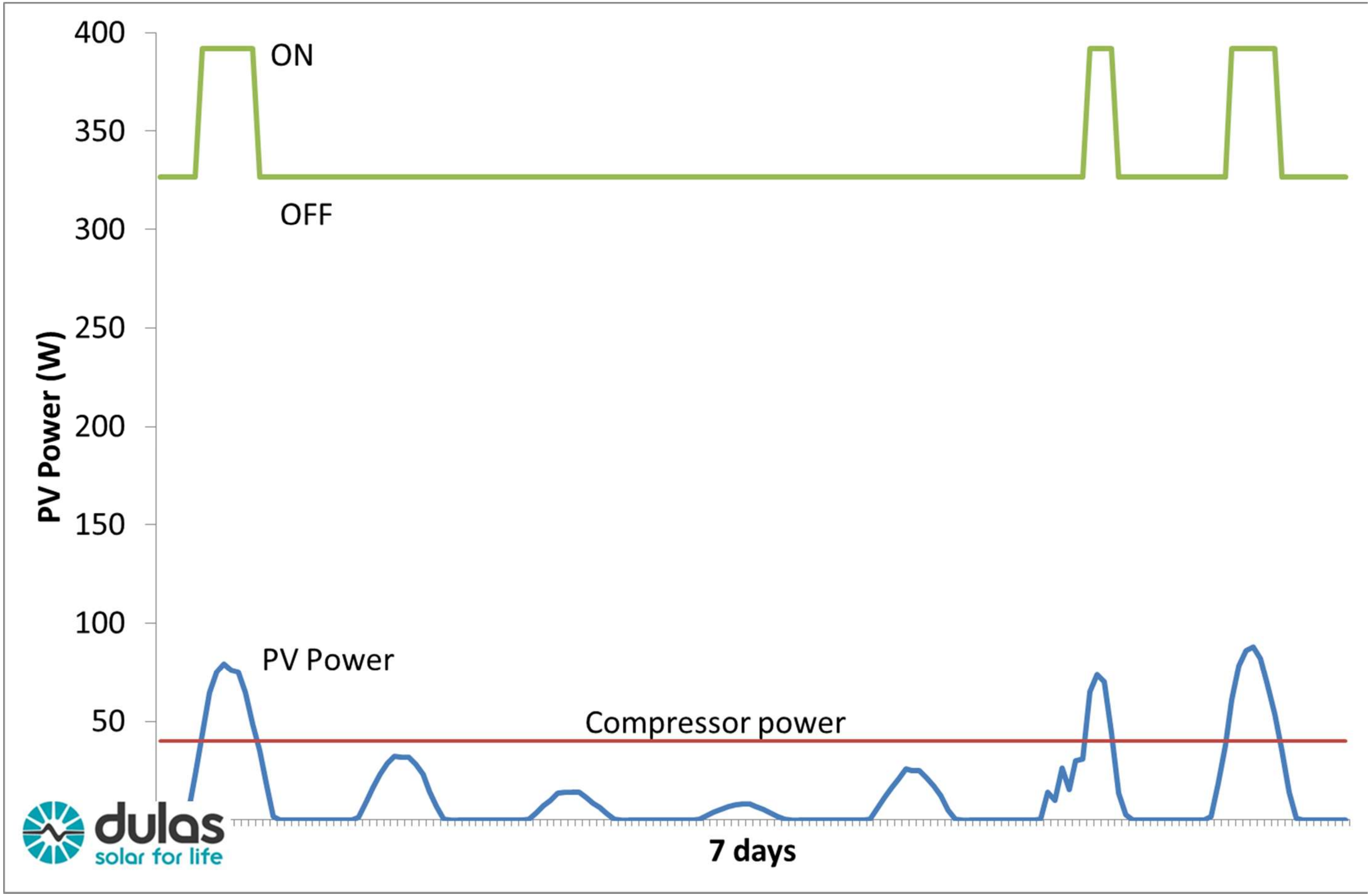
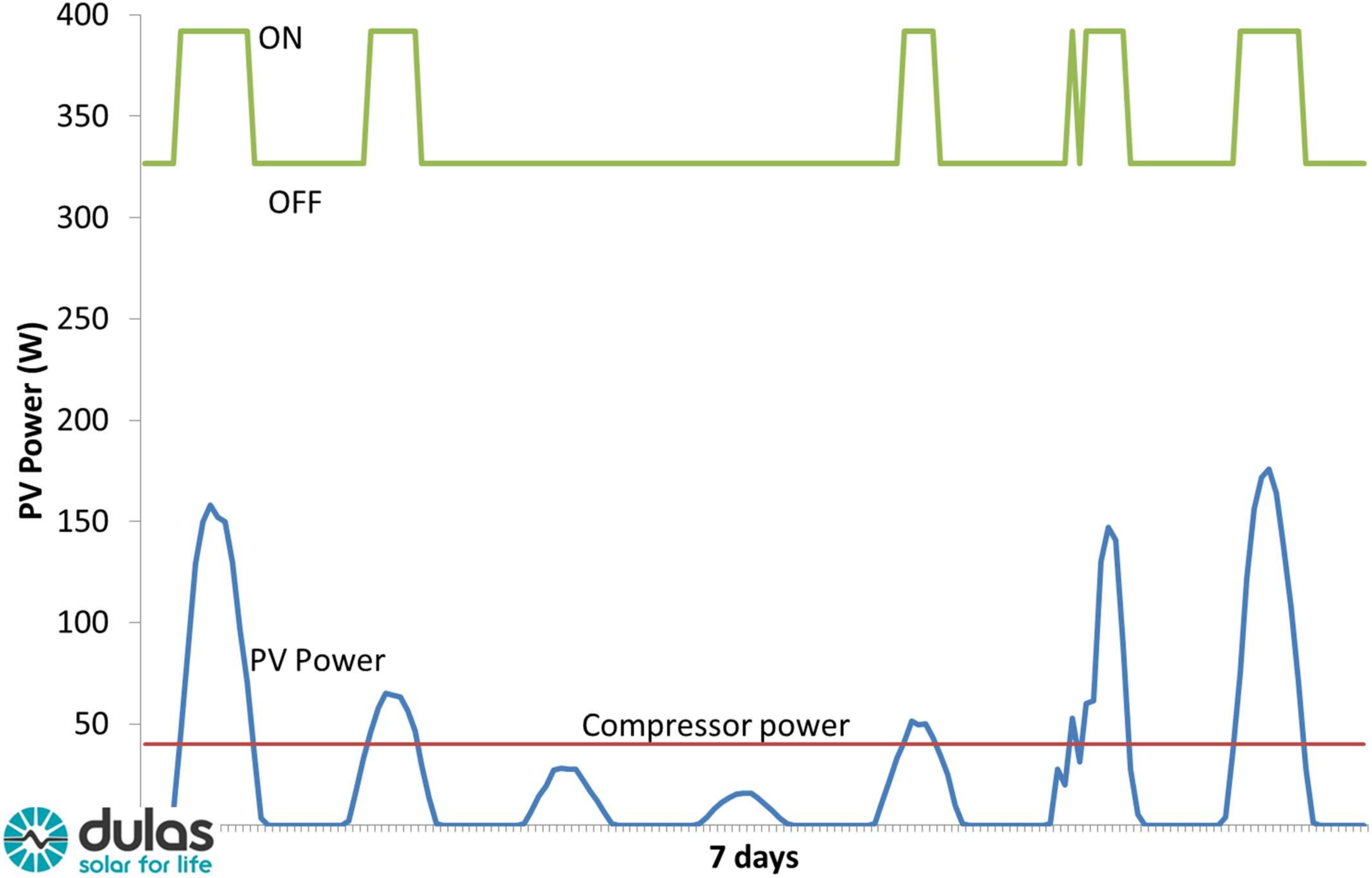
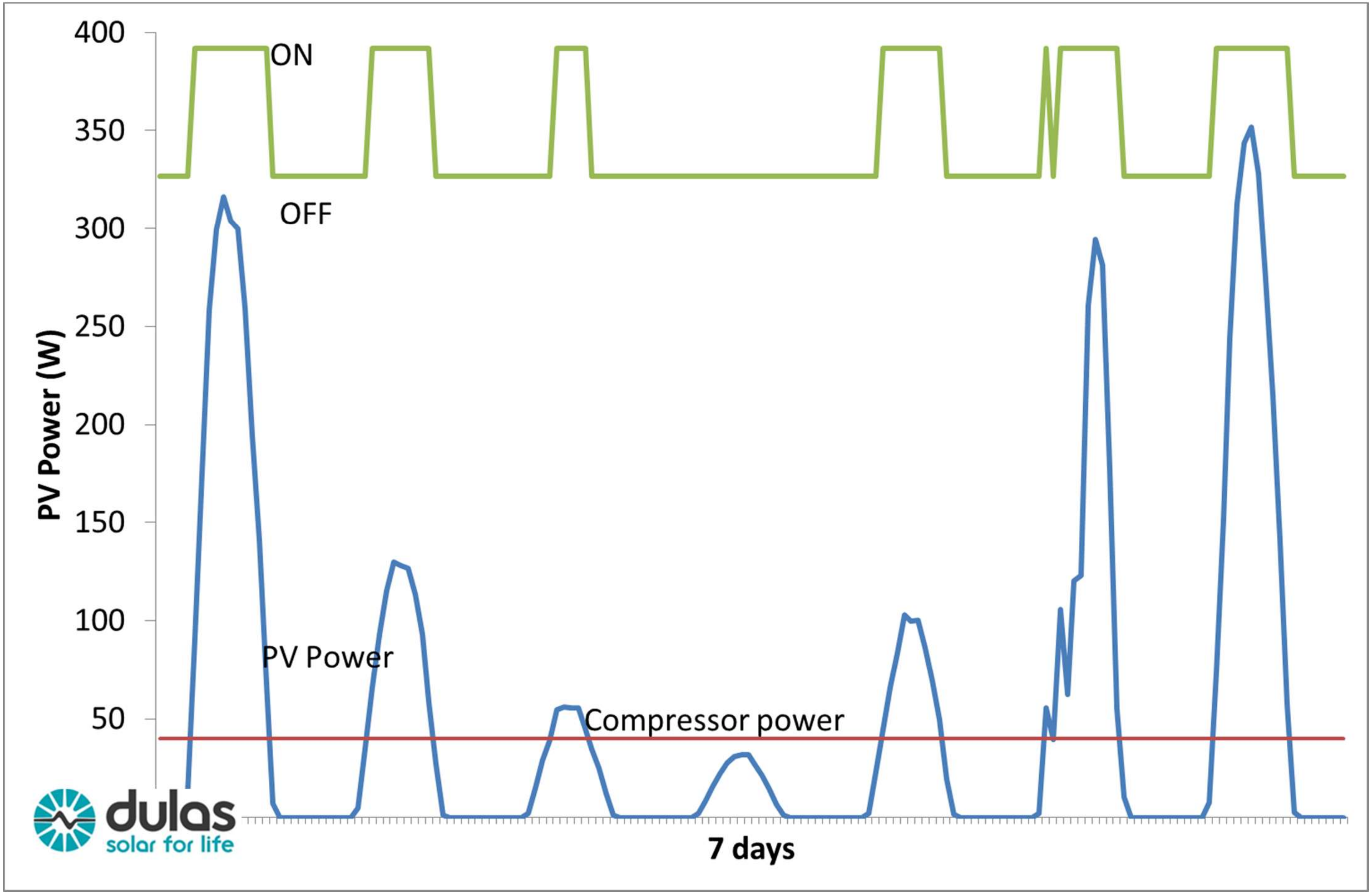
# 100W PV. 19 hour compressor run time.



# 200W PV. 38 hour compressor run time.



# 400W PV. 55 hour compressor run time.



# Previous work on system reliability

**Findings from paper**

- Increasing the size of the PV by 25% means a big reduction in battery size, about 3 times.
- The amount of extra PV or battery required is very site specific.

| | |
|---|---|
| Title of work: | Solar Autonomy Calculation Tool |
| Work for: | PATH |
| Client: | PATH |
| RIfI Number: | 08/MT/00505/C |
| RIfI Consultant: | H. Toma and T. Markvart |
| Work by: | H. Toma and T. Markvart |
| Date: | 14/01/09 |

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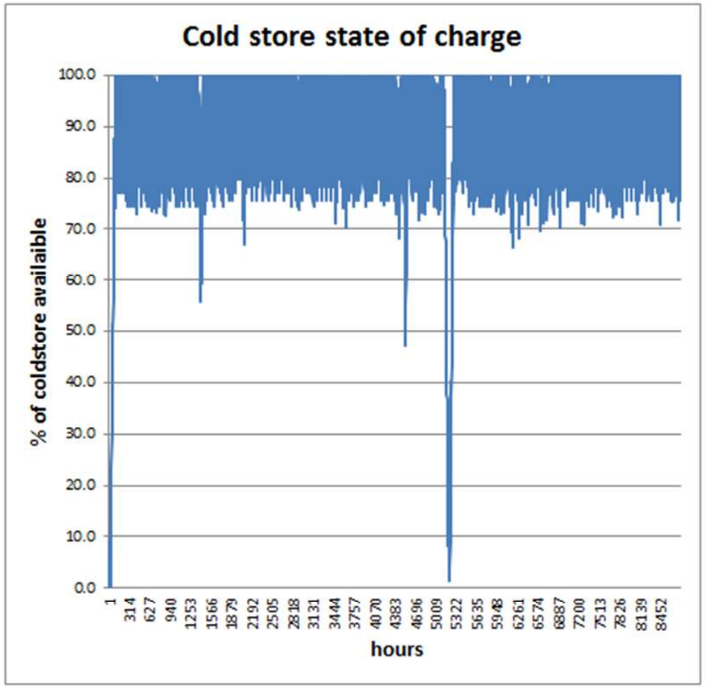
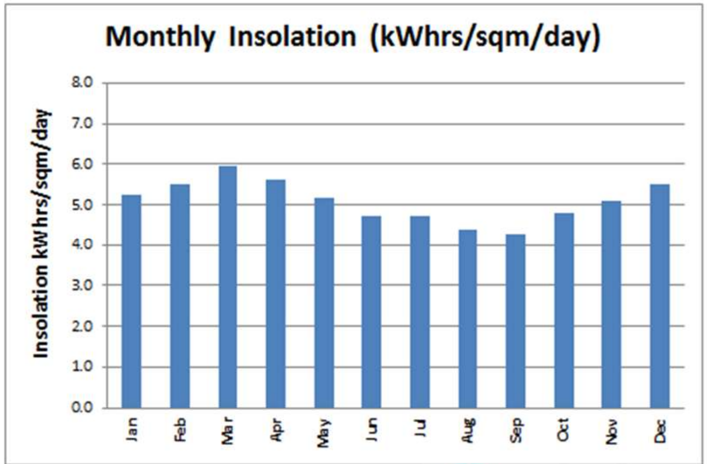
# SDD simulation software – using a year's hourly solar data

## Dulas SDD PV sizing calculator

| | |
|---|---|
| **PV array size inc tilt, dust and temperature correction (Wp)** | **320** |
| Average ambient temperature | 43 |
| Factor for tilt error, dust, and increased cell temp | 1.45 |
| Required Array to Load Ratio | 1.25 |
| cable csa (mm2) | 4 |
| max compressor power | 80 |
| min compressor power | 40 |
| **Autonomy (hours)** | **74** |
| **Site** | **Bangkok** |
| Tilt angle | 15.0 |
| **Loss of load (%)** | **0.0** |
| Average cold store "state of charge" (%) | 87.5 |
| freezer availability (% above threshold) | 61.9 |
| PV value to model | 220.7 |

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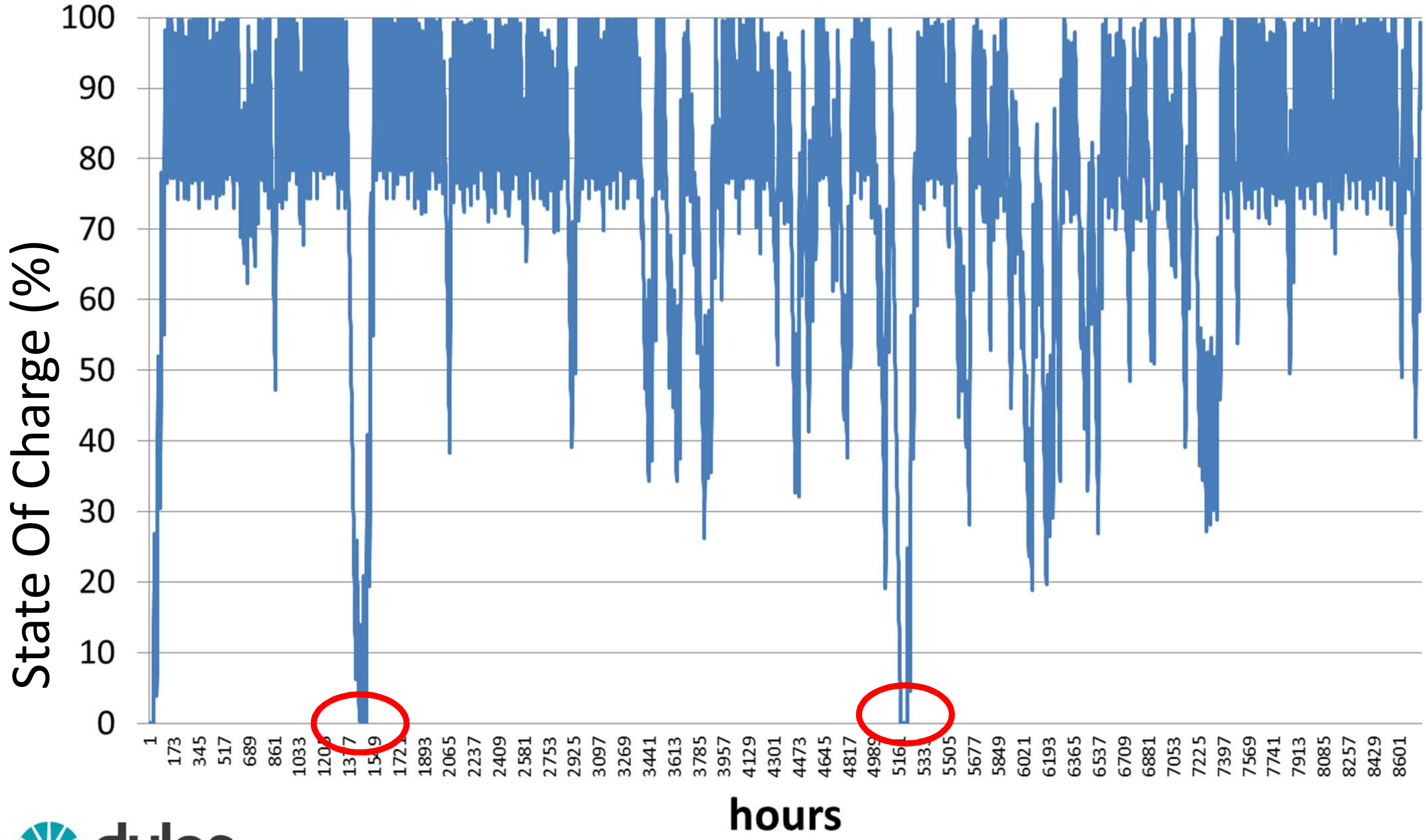
# Simulation output – PV too small – cold store runs out of “cold”.

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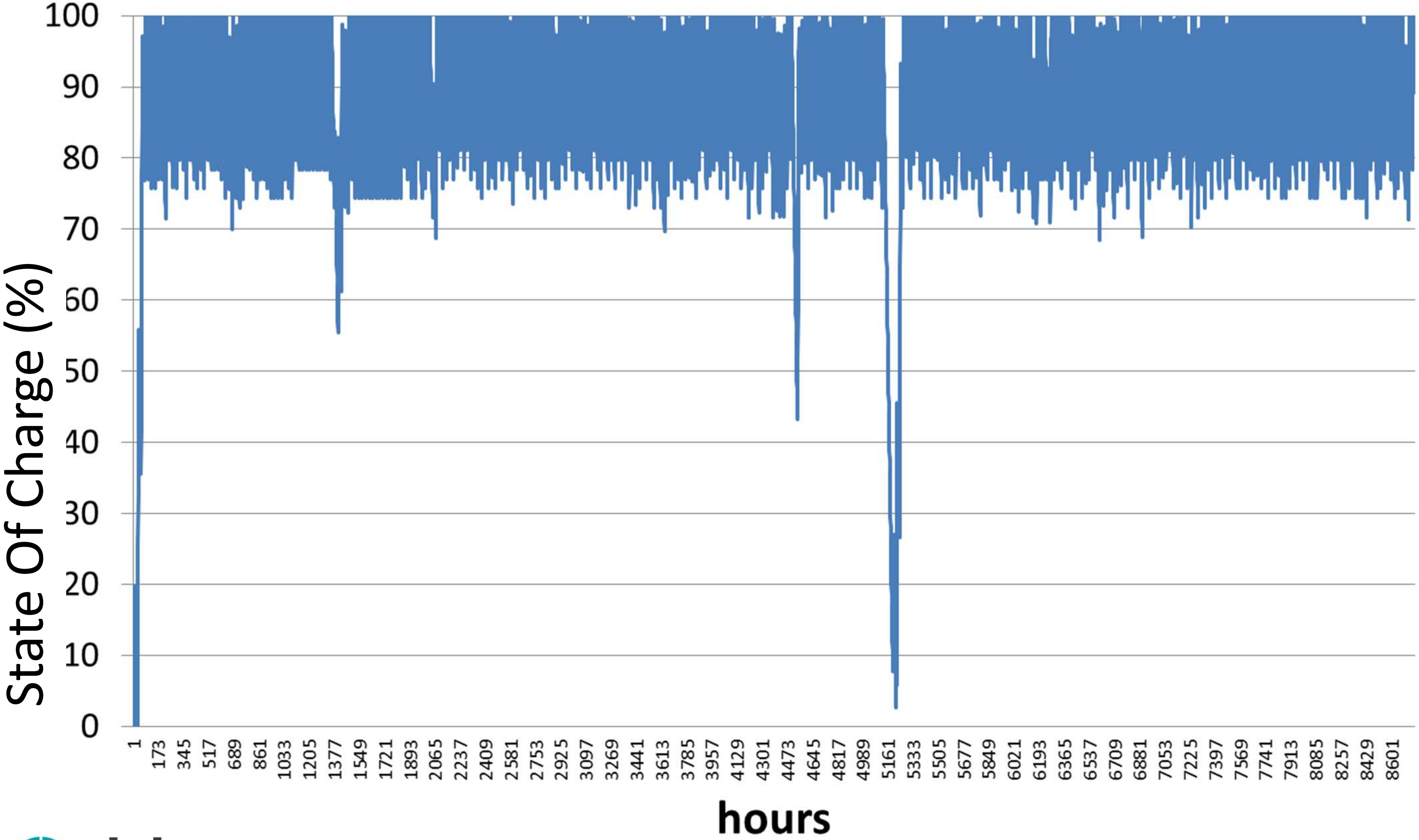
# Simulation output – PV optimally sized.

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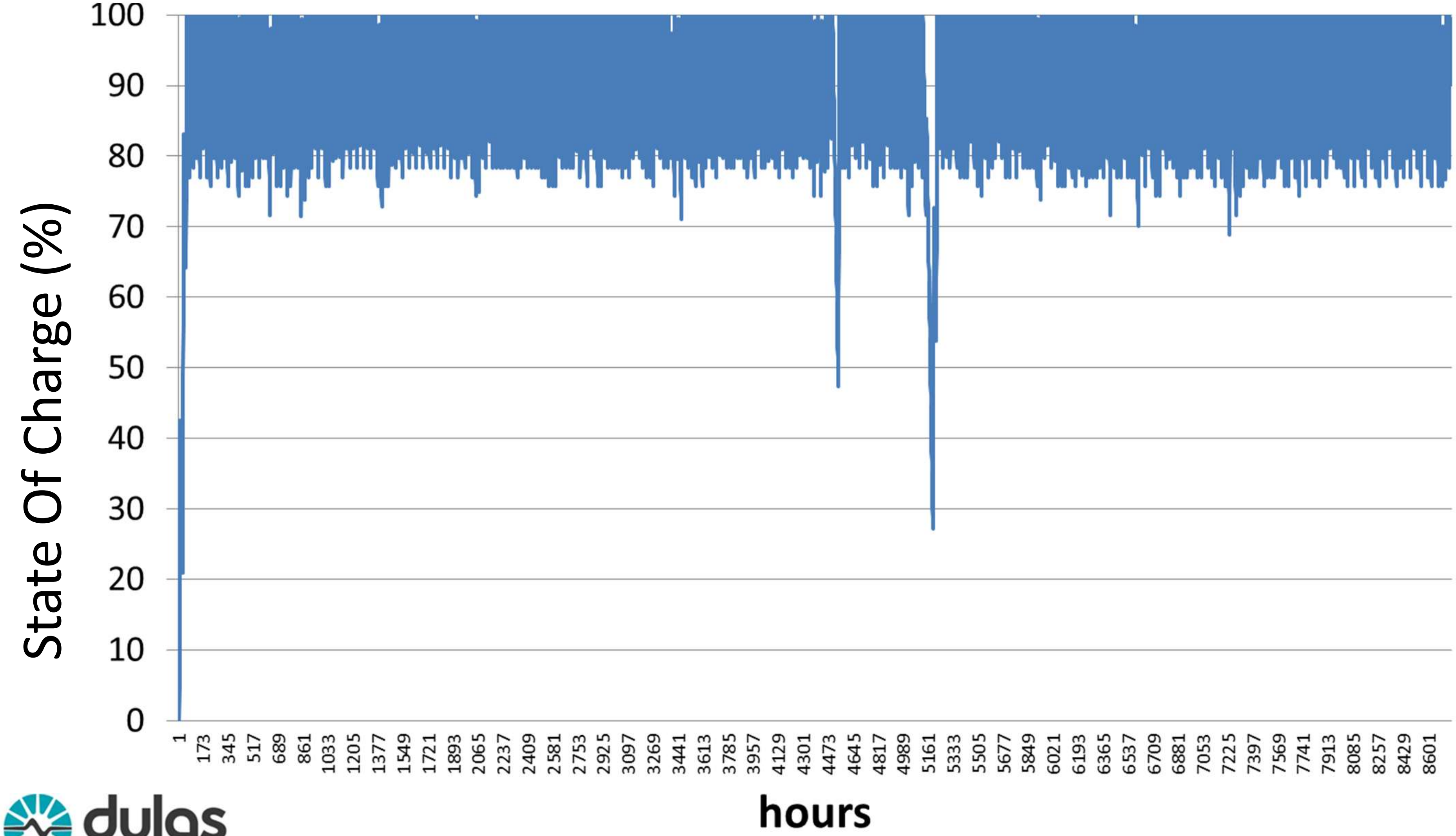
# Simulation output – PV larger than required to allow for those years worse than the average

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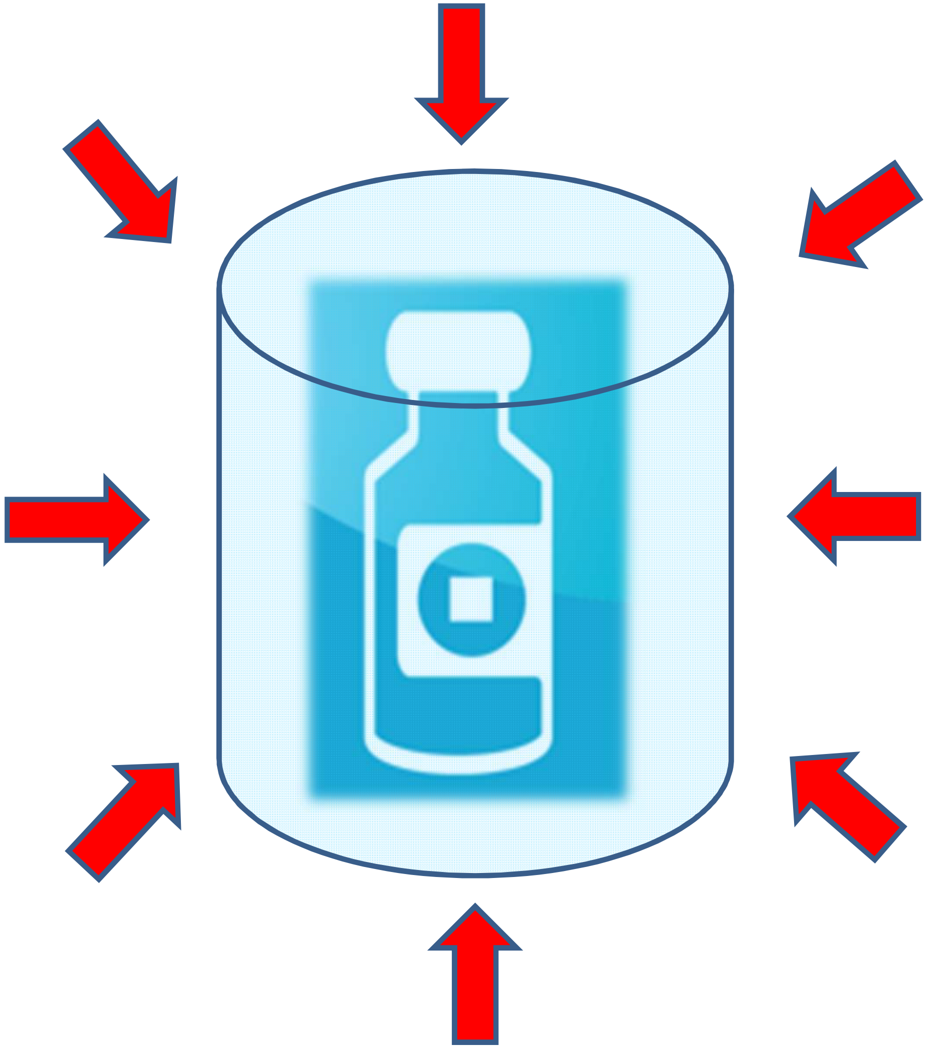
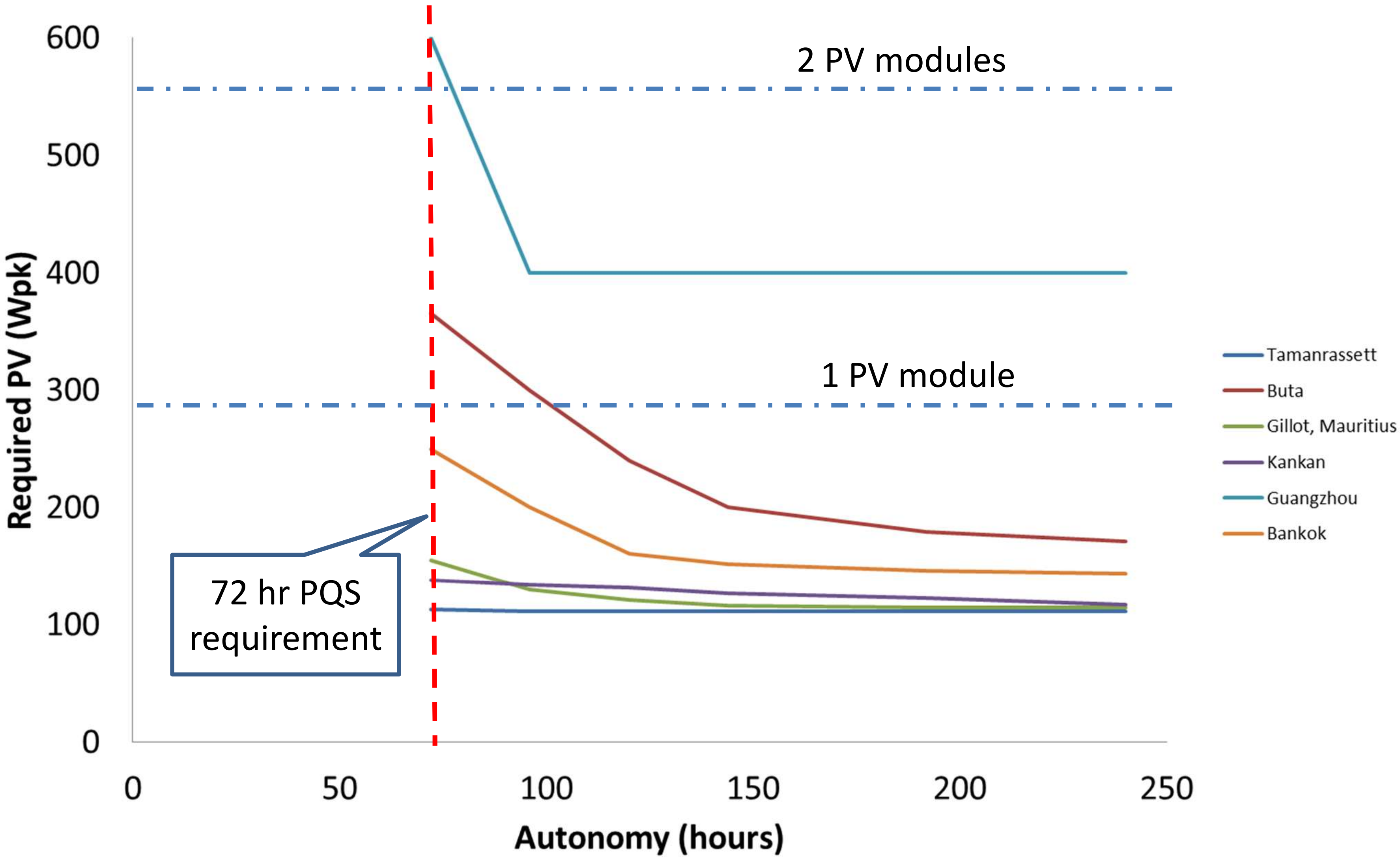
# How long should the cold store last?
# (Autonomy)



# Long autonomy doesn't significantly improve system reliability. It is more effective to increase PV size if necessary.

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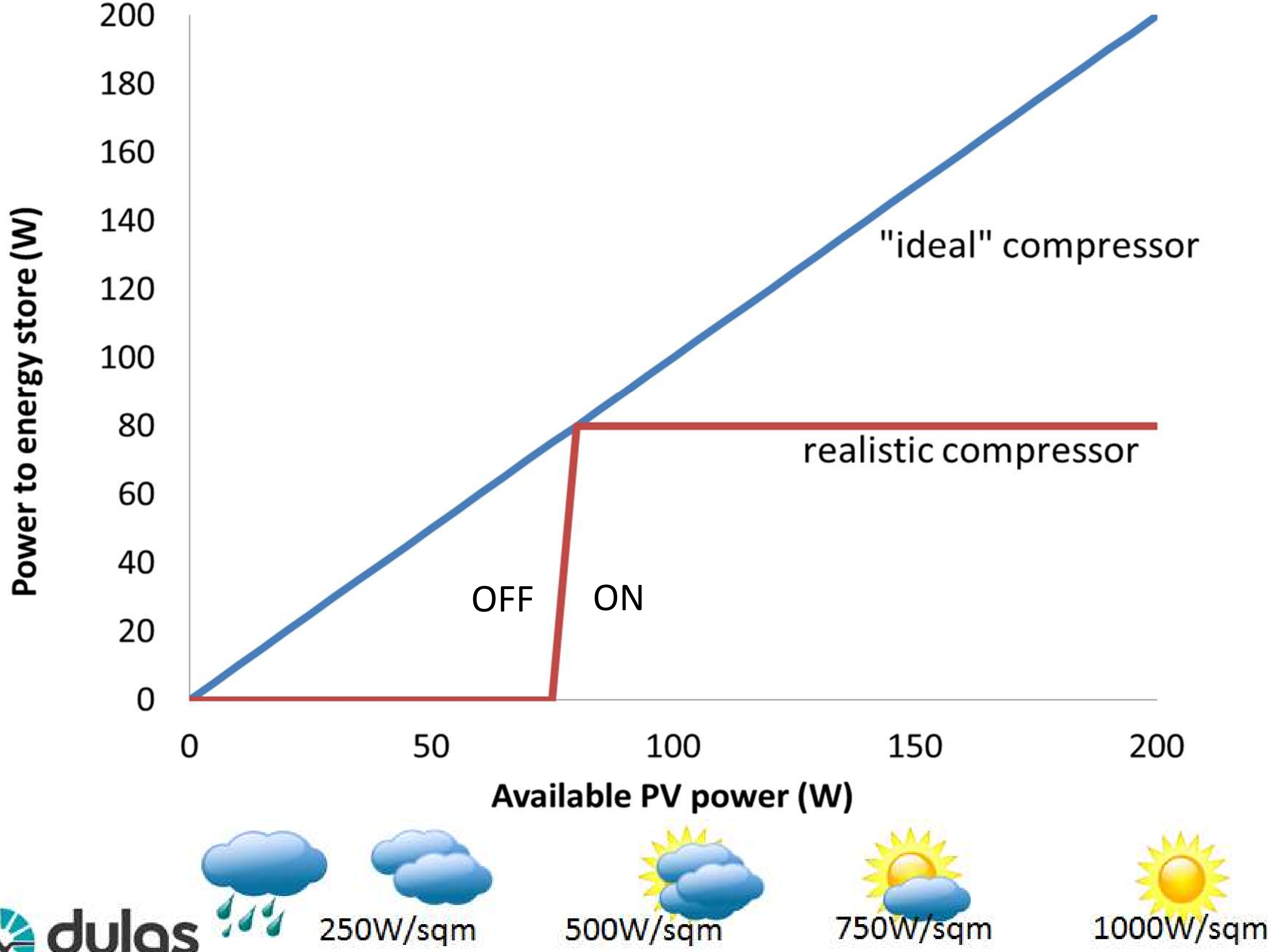
# Getting more energy out of the cold store by improving the match between the compressor and the PV.

# The match between PV and compressor is far from ideal

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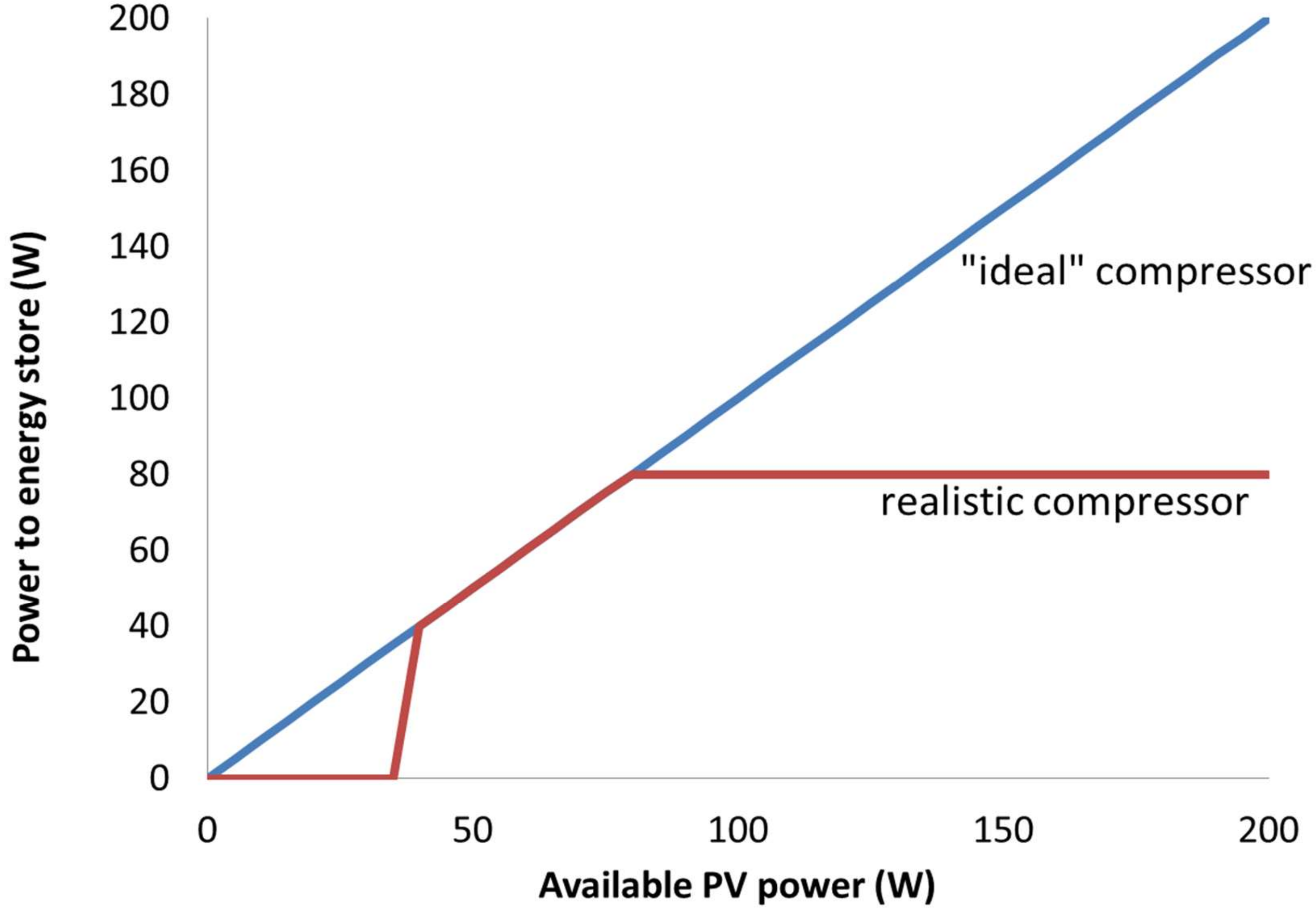
# Energy capture is improved with a power point tracking variable speed compressor





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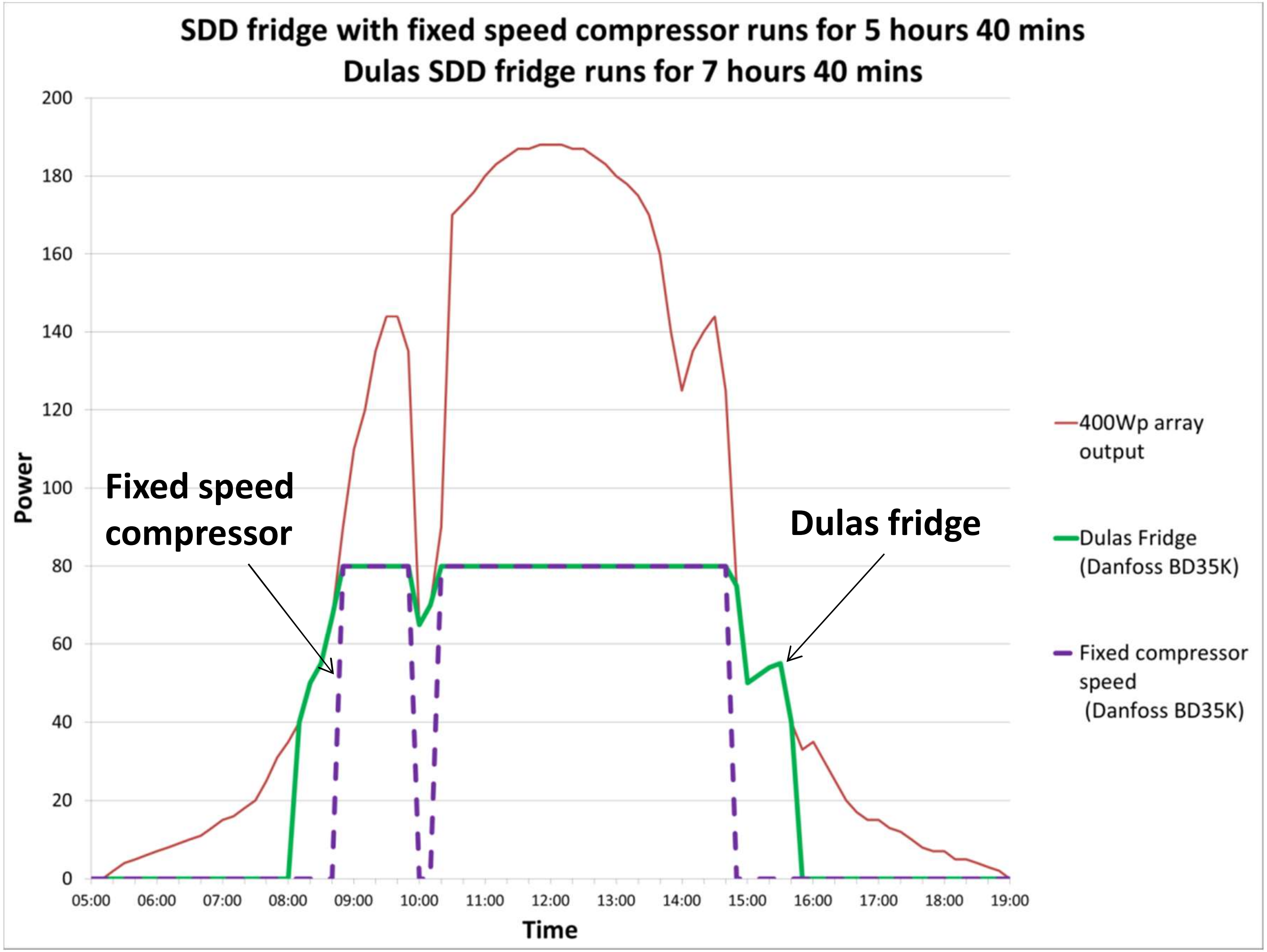
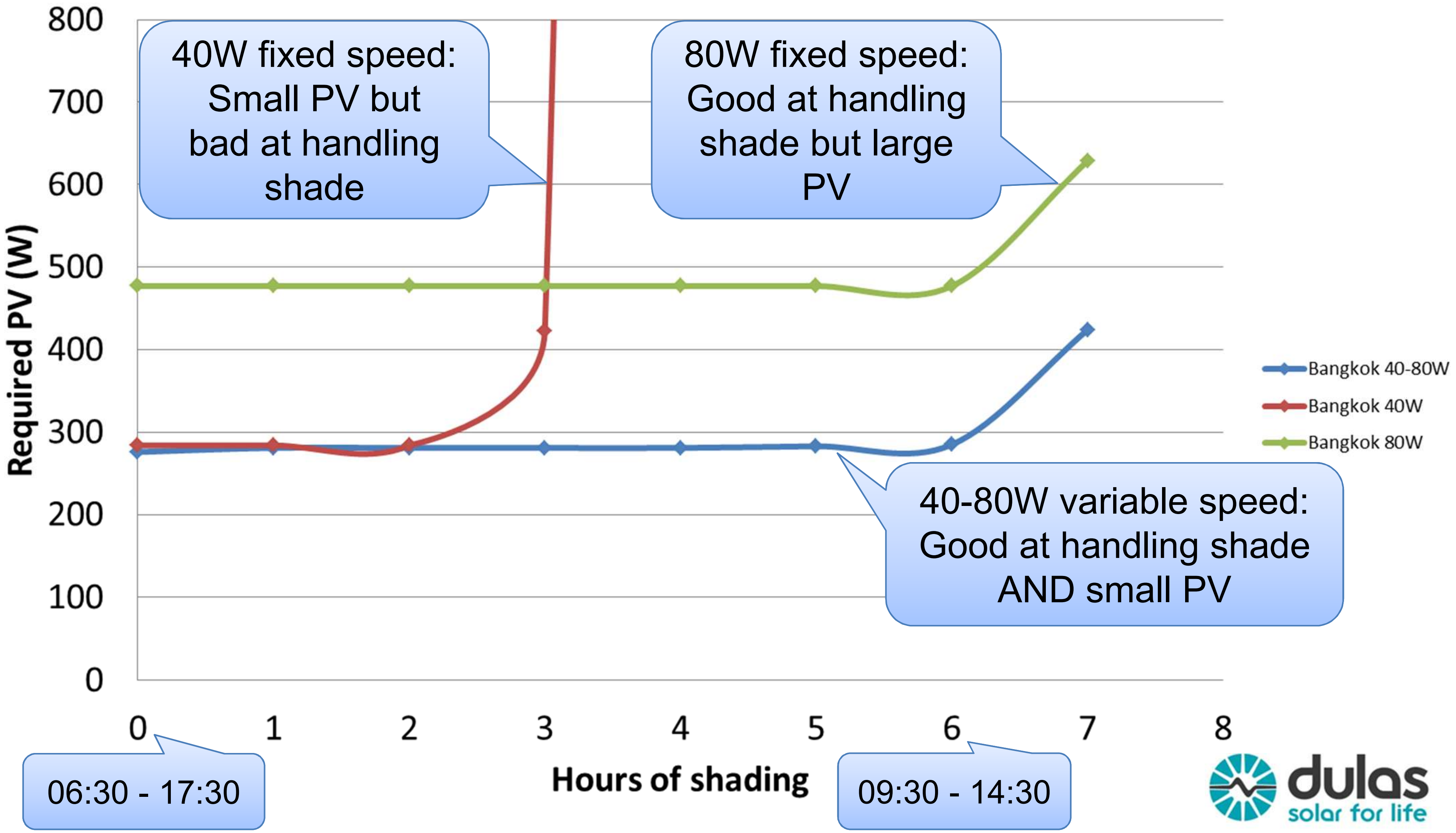



**The variable speed compressor gives a 25% reduction in PV requirements**

# PV shading

# Variable speed power point tracking compressor gives good resilience to shading and smaller PV size.

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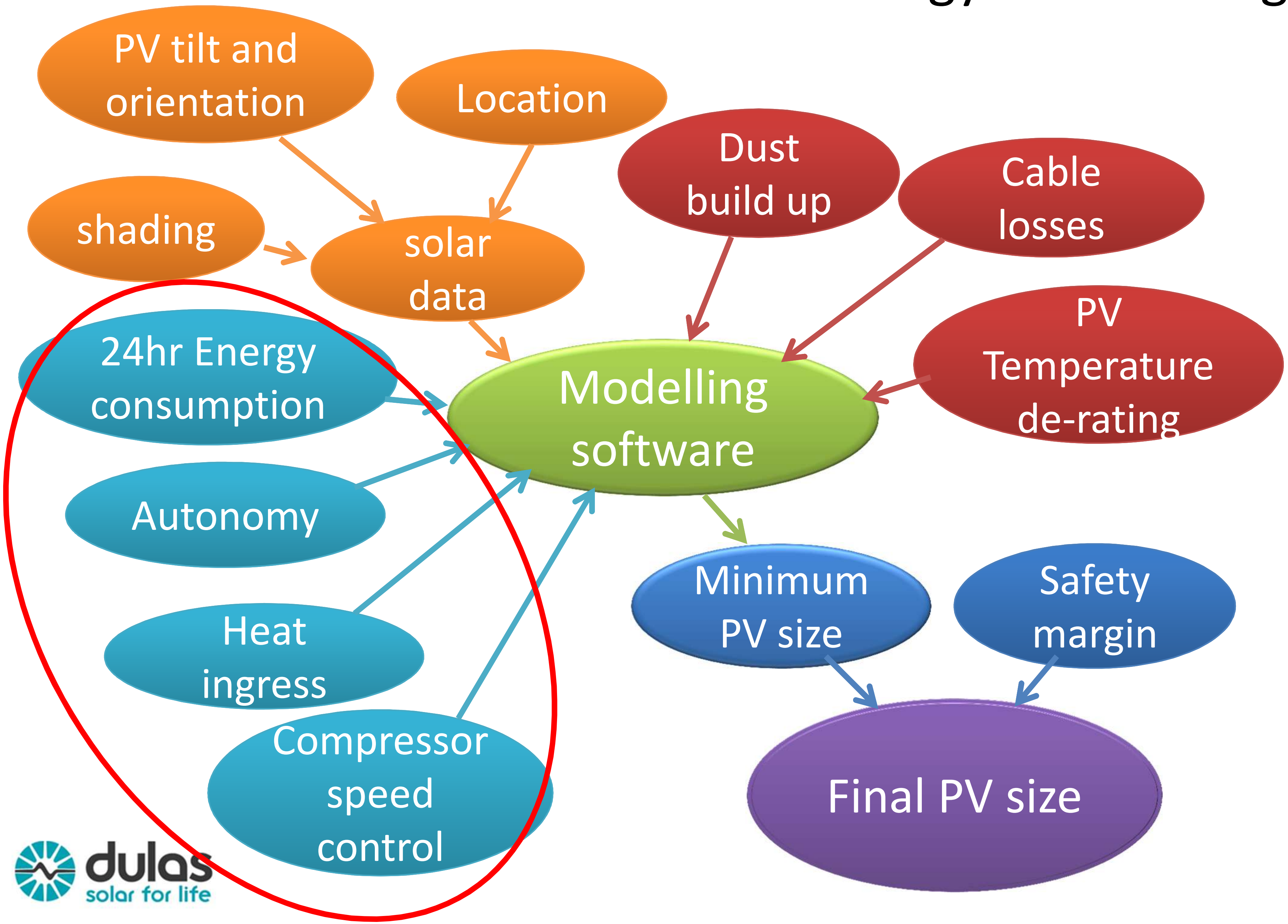
# A robust methodology for PV sizing

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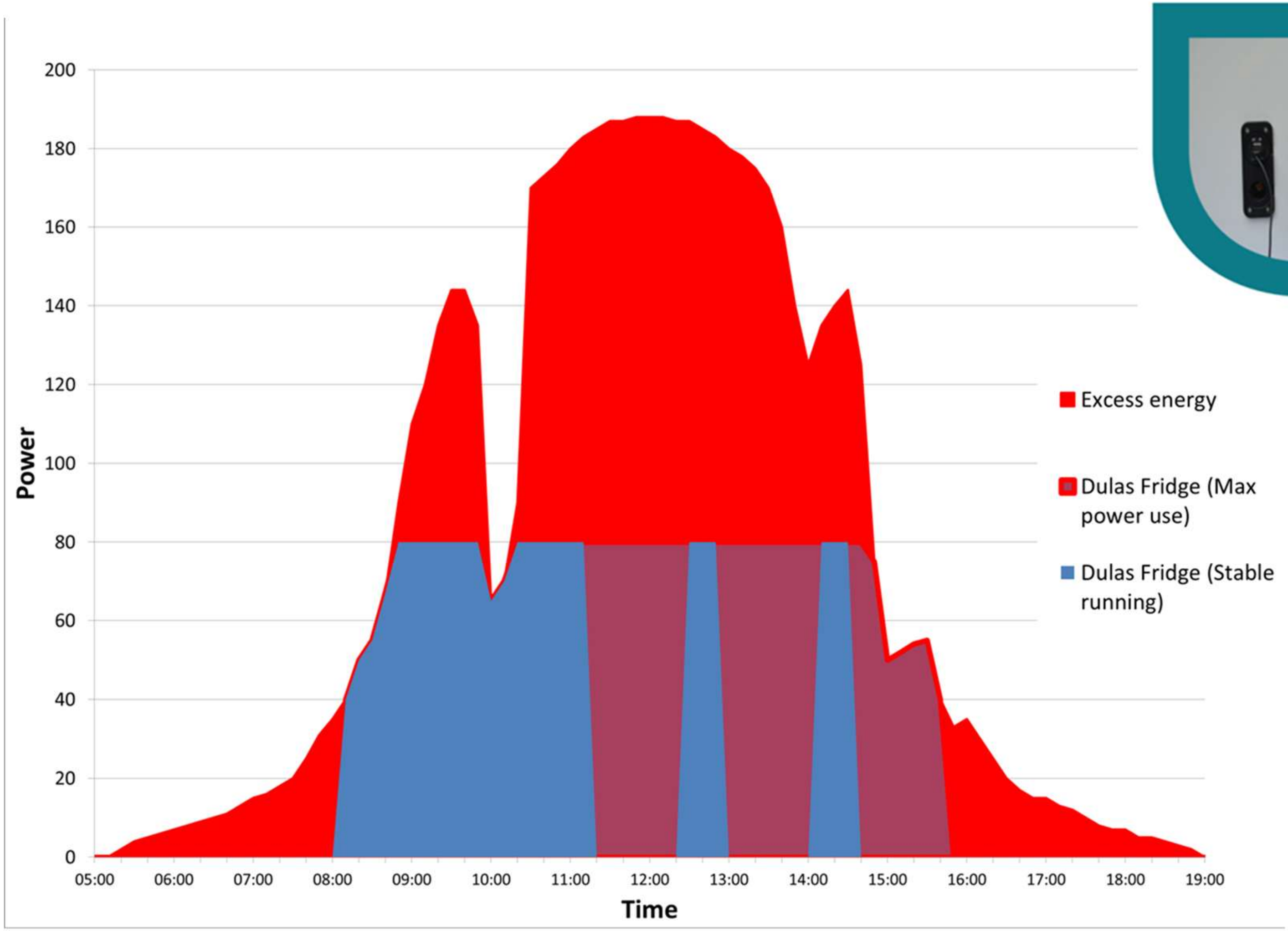
# Conclusions

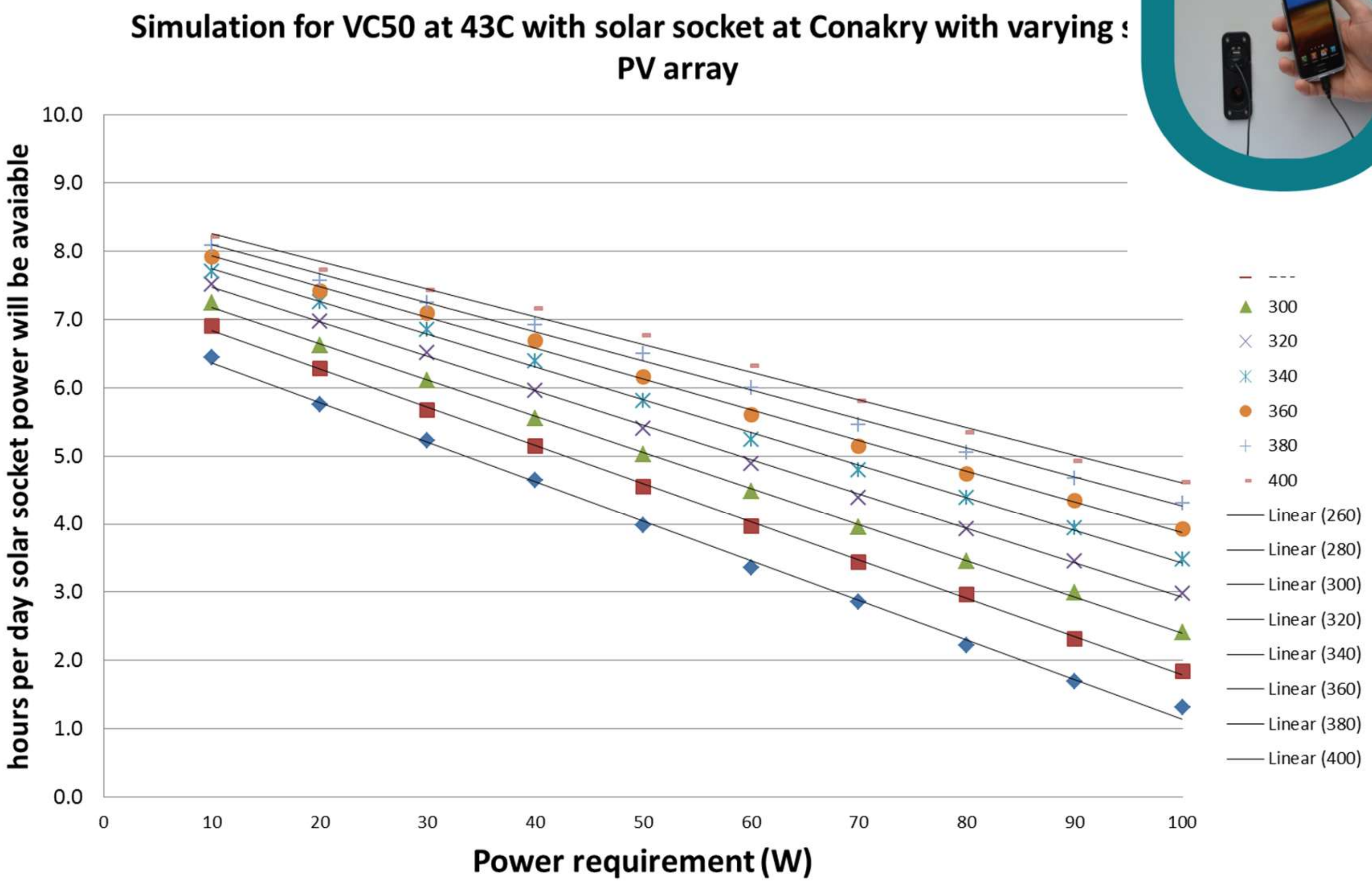
- The PV figures on the PQS data sheet are not the whole story.
- The PV size required depends on location and the individual characteristics of the fridge.
- Modelling with real solar data and a few fundamental  fridge characteristics can lead to reliable SDD fridge systems.
- There is a need for a standardized approach to PV sizing.

# A good design allows other things to follow naturally




Thank you
www.dulas.org.uk

# Energy harvesting design




The same model has been used for assessing our solar socket optimal sizing and performance